CLIMATE DIAGNOSTICS CENTER

Upper Colorado Basin Regional Climate Discussion, 3 Feb 2000

This discussion provides a synthesis of current official NOAA climate and weather forecasts, historical climate analysis, and experimental products and research on climate in the interior West. It is an experimental product for use by individuals interested in water management, with a focus on the Upper Colorado mainstem and San Juan Basins. Developed by the NOAA-CIRES Climate Diagnostics Center (CDC), this product builds on official climate forecasts that are issued by the NOAA Climate Prediction Center (CPC). Available on the web at: *www.cdc.noaa.gov/~ajr/discussion.html.*

Weather patterns for the western U.S. this winter will be influenced by the moderate La Niña now in progress. La Niña, or the cold phase of the El Niño-Southern Oscillation (ENSO), occurs when the eastern equatorial Pacific experiences below normal sea surface temperatures.

La Niña (LN) conditions strengthened in the tropical Pacific in December. CDC has examined the most recent forecasts from a number of models and most indicate that cold episode conditions are expected to persist at least through April 2000. Once established, an ENSO anomaly tends to persist through the winter. April to June is a season in which the La Niña might change to neutral or warm (El Niño), although La Niña conditions have generally persisted in the Pacific since mid-1998.

The official monthly/seasonal forecast issued by CPC primarily reflects the history of past La Niña winters in the region. To interpret the forecast maps (Fig. 1), consider that one would expect by chance that 33% each of years would be normal, i.e., in the middle tercile, below normal (lower tercile), or above normal (upper tercile). The plots indicate the change in risk from these terciles. The current forecast for the southwestern US is for increased risk of precipitation in the lower tercile for both February and for the February-April season. The risk of below normal precipitation increases to 33-38% for the light yellow areas in the map on the right; and to 53-63% risk, or nearly doubled, of lower tercile precipitation for southern New Mexico (darkest red). Green shadings indicate increased risk of wet conditions in the Pacific Northwest.

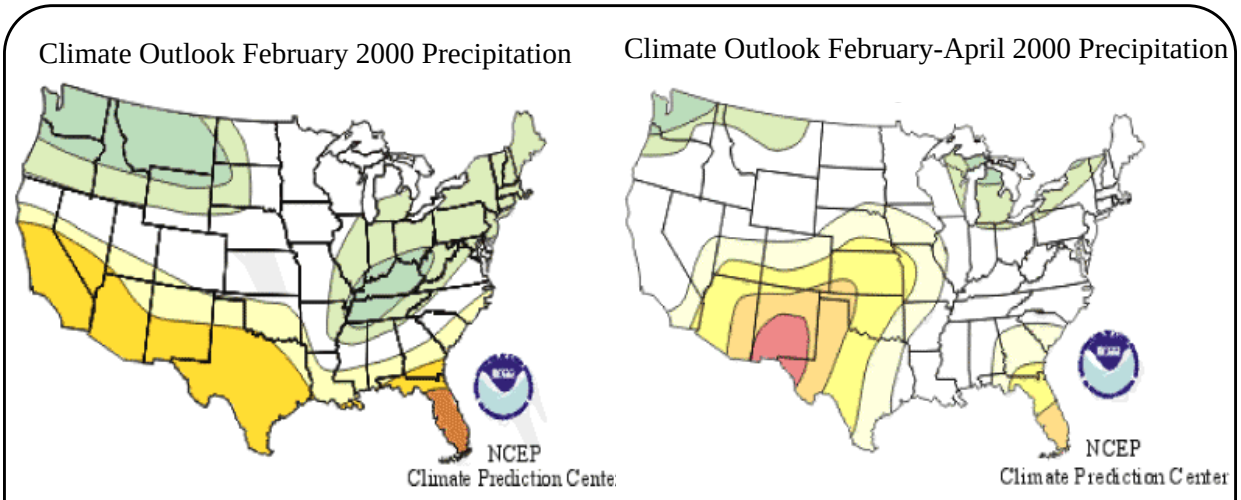

Figure 1. Current official NOAA/CPC Monthly and Seasonal Forecast. For complete description and other seasons see *www.cpc.ncep.noaa.gov.* Next forecast will be issued 17 Feb.

Historical analyses

Extremes of temperature and precipitation can occur at any time. However, La Niña and El Niño influence the relative frequency of certain climate extremes in the United States. Schematic histograms of rainfall (Fig.2) illustrate how the frequency of extremes can change due shifts in mean rainfall that may be induced by La Niña or El Niño. The following discussion presents the analysis of four types of historical data to illustrate the conditions typical of La Niña winters.

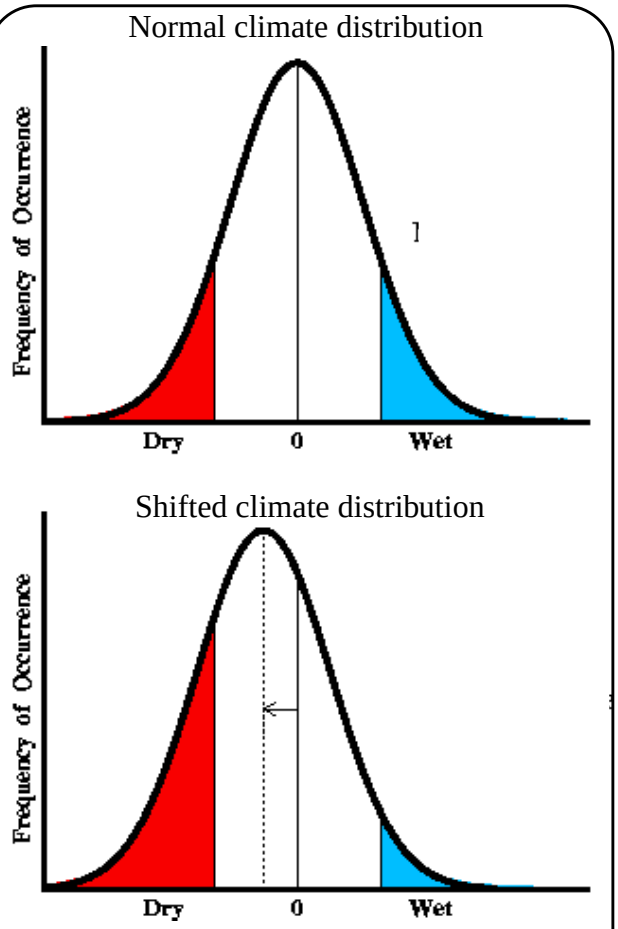

Figure 2. Relative frequency of extremes changes, if the mean changes making some conditions more likely than others.

First, analysis of climate division data reveals regions of increased risk of extreme dry or wet conditions during a La Niña event (Fig. 3). Colored climate divisions on the map indicate changes in risk of dry or wet conditions compared to quintiles, from the wettest 20% of years to the driest 20%. For much of the Colorado basin and the Southwest, there is a doubled risk in La Niña years that February through April conditions will be among the driest 20% of historical values.

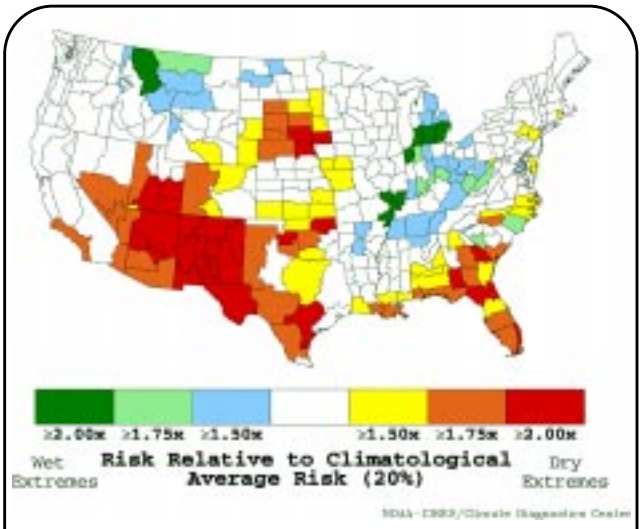

Figure 3. February-April extremes during La Niña: risk of extreme wet or dry years. See: *www.cdc.noaa.gov/~cas/atlas.html* for other seasons and temperature.

Second, a sense of how La Niña impacts vary within a season can be gained from analysis of individual months in climate station data. In most La Niña years, January has received average or above average precipitation in the northern and central Colorado mountains. This signal continues into February. There is not a significant impact on the San Juans in this data (figures not shown).

In contrast, March, has been significantly dry during La Niña throughout the Southwest. April precipitation has been quite variable among past La Niñas; however, a repeat of last year's April storms should not be counted on. If La Niña continues into the summer, the Southwest also tends to experience dry conditions during May and June. As such, water deficits could continue to accrue.

A third type of historical analysis is of snowcourse data, aggregated into several river basins (Figure 4). The response to La Niña in the Colorado basin varies by time of year and along a north-south axis. Further north, the Upper Green basin and the Colorado headwaters have averaged above normal snow pack in La Niña years. The lower Green and Lake Powell drainages, and the aggregated Gunnison, Dolores, and San Juan basins tend to be normal or slightly above average before March, then dry anomalies develop. However, there is considerable variability among years, and within a year, one large storm can make the difference between a dry and an average year or an average and a wet year.

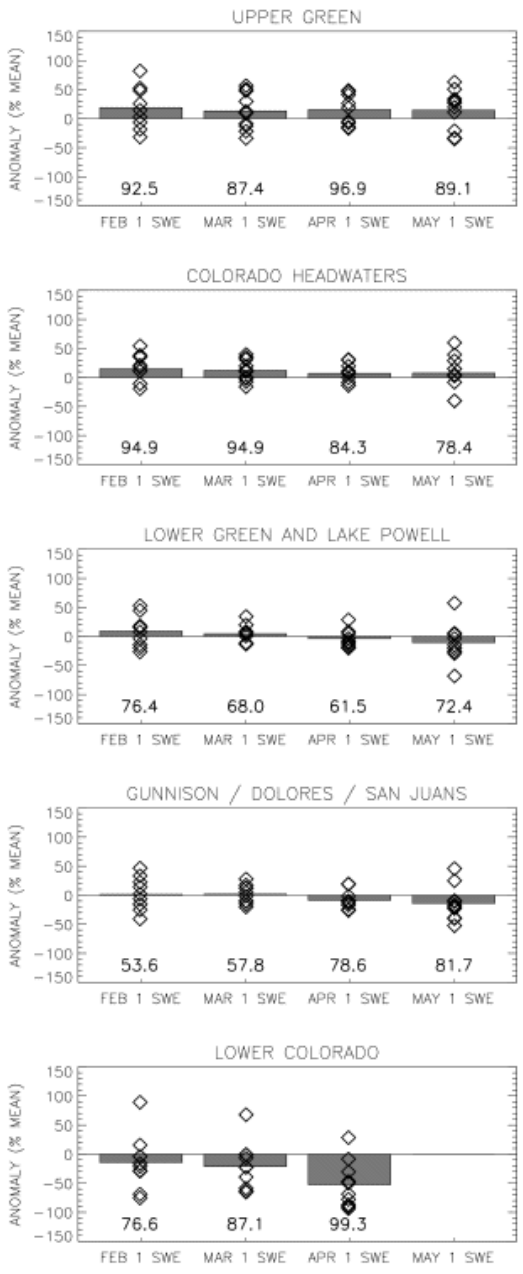

Figure 4. Anomalous snow water equivalent (SWE) in LN years as percent of the mean. Diamonds represent 10 LN years, bars the composite mean; numbers are the statistical significance levels. Courtesy M. Clark.

Finally, streamflow data in La Nina years have been analyzed to determine the probabilities that seasonal flows will fall in upper or lower terciles of long-term average flows. Streamflow averages the conditions over both the snow accumulation season and the runoff seasons. A experimental streamflow product recently developed for the upcoming spring, indicates decreased risk (23%, vs. 33% expected by chance) of upper tercile April-July flows in the Gunnison tributaries, and increased risk (43% or higher) of lower tercile flows (Dettinger et al, *www.iges.org/ellfb*, figures not shown). No significant changes in risk were found for gauges on the Animas, a San Juan tributary.

1999-2000 and historical context

How do these historical analyses compare to the evolution of the snow this year? Both the monthly climate station analysis and the snowcourse data indicate that near normal snowpack could be expected by February 1 of a La Niña year. This year, however, snowpack is well below the long-term average: southwestern Colorado basins are at 41% SWE compared to long-term average, 26% for the San Juan basin of New Mexico. The Upper Colorado and Upper Green are somewhat better at 75-80% (see *www.wrcc.dri.edu* for SNOTEL data).

For the early part of this winter, atmospheric circulation was in a typical La Niña pattern, with weak westerlies across the Southwest, which are associated with low precipitation. During mid-to-late January the westerlies intensified and storm tracks shifted south, bringing moisture and snow to the central Rockies and San Juans, where snowpack has increased, although it is still low. Historical data suggests that this more active stormtrack, reflected as higher precipitation, is not unusual during La Niña for a periods in January

and February. CDC's experimental 8-14 day forecast, suggests that this pattern will remain into early February, with a greater than 50% chance of upper tercile precipitation in much of the Southwest (*www.cdc.noaa.gov/~jsw/week2*).

However, this pattern is not likely to persist for much longer, and by mid-February, the system is likely to be back in a typical La Niña circulation, with associated low likelihood of significant precipitation. CPC forecasts indicate that the February-April season will be dry, and historical data also suggests that March is dry during most La Niña years.

Historic streamflow analysis is in agreement: during La Niña, the Gunnison sub-basins typically experience enhanced risk for lower tercile flows in the April-July period. The same analysis found no significant risk of either upper or lower tercile flows for the Animas; however, current snowpack is very low in the San Juans. In addition, observed temperatures have been anomalously high, and are forecasted by CPC to remain high through the spring, which would contribute to earlier and reduced runoff.

Outlook

There is little climate information to suggest a significant increase in snowpack in the Southwest after mid-February, if La Niña patterns persist, as is forecast. In the current NOAA Climate Prediction Center forecast, increased likelihood of below normal precipitation continues in March-May and April-June seasons. Historical analysis of La Niña spring and summers in climate division data also reveals increased risk of dry conditions for April-June in the Upper Colorado and San Juan basins (*www.cdc.noaa.gov/~cas/atlas.html*).

Historically, precipitation and snowpack anomalies tend to accumulate through a La Niña year. Forecasts are also for continued dry conditions, so there is cause for concern that the Gunnison, San Juan, Lower Green, and Upper Colorado drainages will have anomalously low snowpack as the runoff season approaches, and thus anomalously low runoff. This is consistent with NRCS streamflow forecasts.

Useful links:

NOAA Climate Diagnostics Center, *www.cdc.noaa.gov*, including monitoring of US precipitation and the maproom (experimental products), climate info links: *www.cdc.noaa.gov/ClimateInfo*
NOAA Climate Prediction Center, *www.cpc.ncep.gov*; this site includes the U.S. Threats Assessment, Monthly/Seasonal Forecasts, and Winter Outlook, and CPC ENSO Diagnostic Advisory (11 Jan), *www.cpc.noaa.gov/products/analysis_monitoring/enso_advisory/index.html.*
NOAA Colorado Basin River Forecast Center, *www.cbrfc.gov, streamflow forecasts*
USDA Natural Resource Conservation Service, *www.wcc.nrcs.usda.gov/water/w_qnty.html*, streamflow forecasts
SNOTEL data, *www.wrcc.dri.edu/snotel_climate.html*, and SNOTEL summary by basin *www.uc.usbr.gov/wrg/index.html*
Western Regional Climate Center, *www.wrcc.dri.edu*
National Drought Monitor, *enso.unl.edu/monitor/monitor.html*

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3 February 2000